Proper Pilot Testing

The Key to Vapor Intrusion Success

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Presentation Goals

- Outline solid pilot test and system design methodology for retrofit SSD systems.
- Contrast best practices for successful mitigation systems with real world examples of successful mitigation systems.

Site Characterization

Initial background information that establishes project goals

- Driven by:
  - Concurrent construction activity:
    - New construction
    - Substantial rehabilitation
    - None
  - Regulatory authority
  - Building use type
  - Deed restrictions
  - Responsible party requirements

Chemical(s) of Concern (COC)

- Identify and quantify COCs in the Sub Slab Soil Gas (SSSG).
  - Dictate PPE requirements for pilot test and installation
  - Physical properties and quantity may dictate system components.
  - Intrinsically safe fans for potentially explosive airstreams
  - Reactions between COC and conveyance pipe type

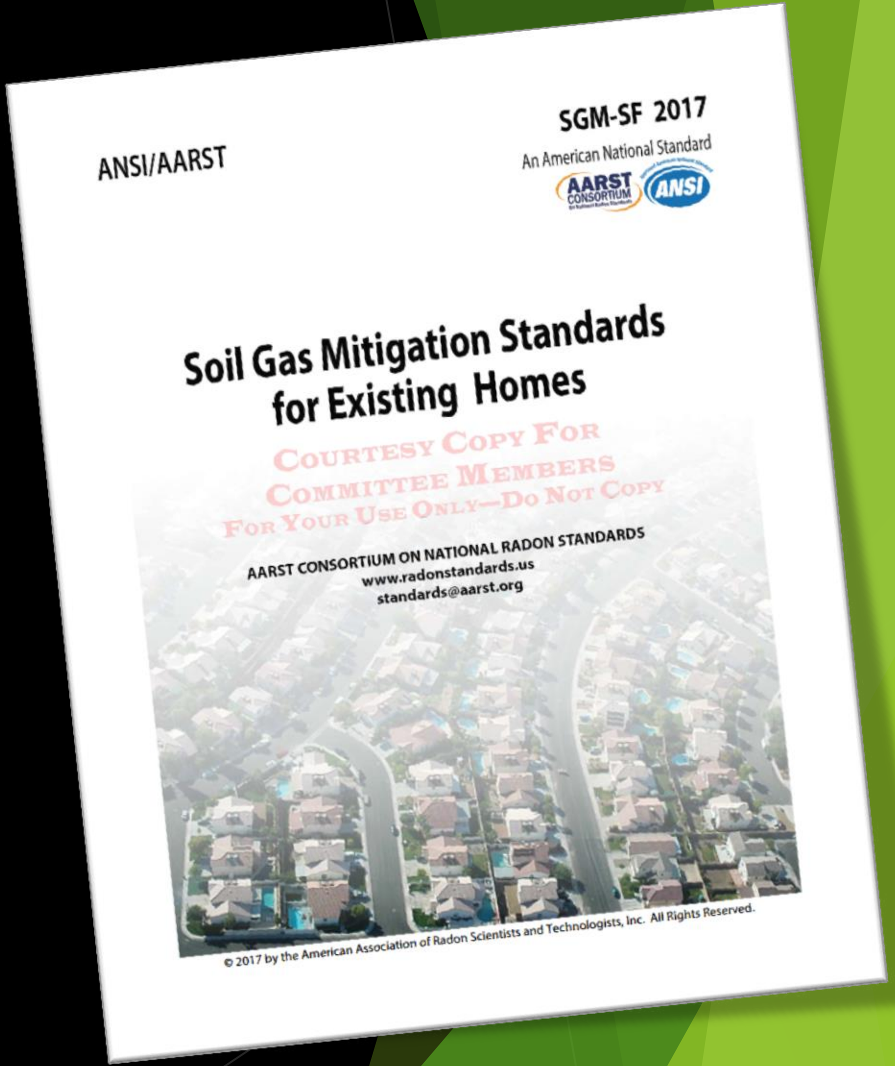
Choose Correct Installation Standard

Mitigation standards have existed for SSD systems for over 20 years.

- ANSI/AARST Consortium
  - SGM – LB – Large Building Mitigation
  - SGM – MF – Multifamily Building Mitigation
  - SGM – SF – Residential Building Mitigation
  - CC1000 – Large Building New Construction
  - RRNC 2.0 – Residential New Construction
- American Society for Testing Materials
  - ASTM E2121 – Low Rise Building Mitigation

<u>Standards are beneficial to everyone involved!</u>

- Design professionals rely on them as a guide to proper installations
- Regulators use them as a ruler to measure proper design
- Clients use them to ensure they are getting the proper solution to their problem



VI Specific Mitigation Standards

Published in 2017, ANSI/AARST SGM - SF is the first standard to include Vapor Intrusion specific requirements.

- All other ANSI/AARST Standards will be harmonized to include these requirements in their next scheduled update.

Establish the Differential Pressure Benchmark

The benchmark, expressed in Inches of Water (WC), is the required differential between the sub slab and the indoor air.

The challenge here is to utilize a number that ensures a pressure differential exists at all times, without wasting energy.

The pressure in the system fluctuates depending on exterior temperature, barometric pressure and other weather events.

Common Pressure Benchmarks (WC)

- -0.004” New Jersey
- -0.032” Most New England states
- -0.020” US EPA most of the time
- -0.004” to -0.020” OH- depending on the proj

Define the Treatment Area

The treatment area is the area of the building where VI is believed to occur.

- Houses:
  - Typically the entire footprint of the building
  - Don’t forget the garage slab
- Commercial buildings under 10,000 ft2:
  - Typically the entire footprint
- Commercial buildings over 10,000 ft2:
  - Typically only a portion of building
  - Delineated by:
    - Column lines
    - Additions to the building
    - Known UST and AST areas
    - Previous known use of the building

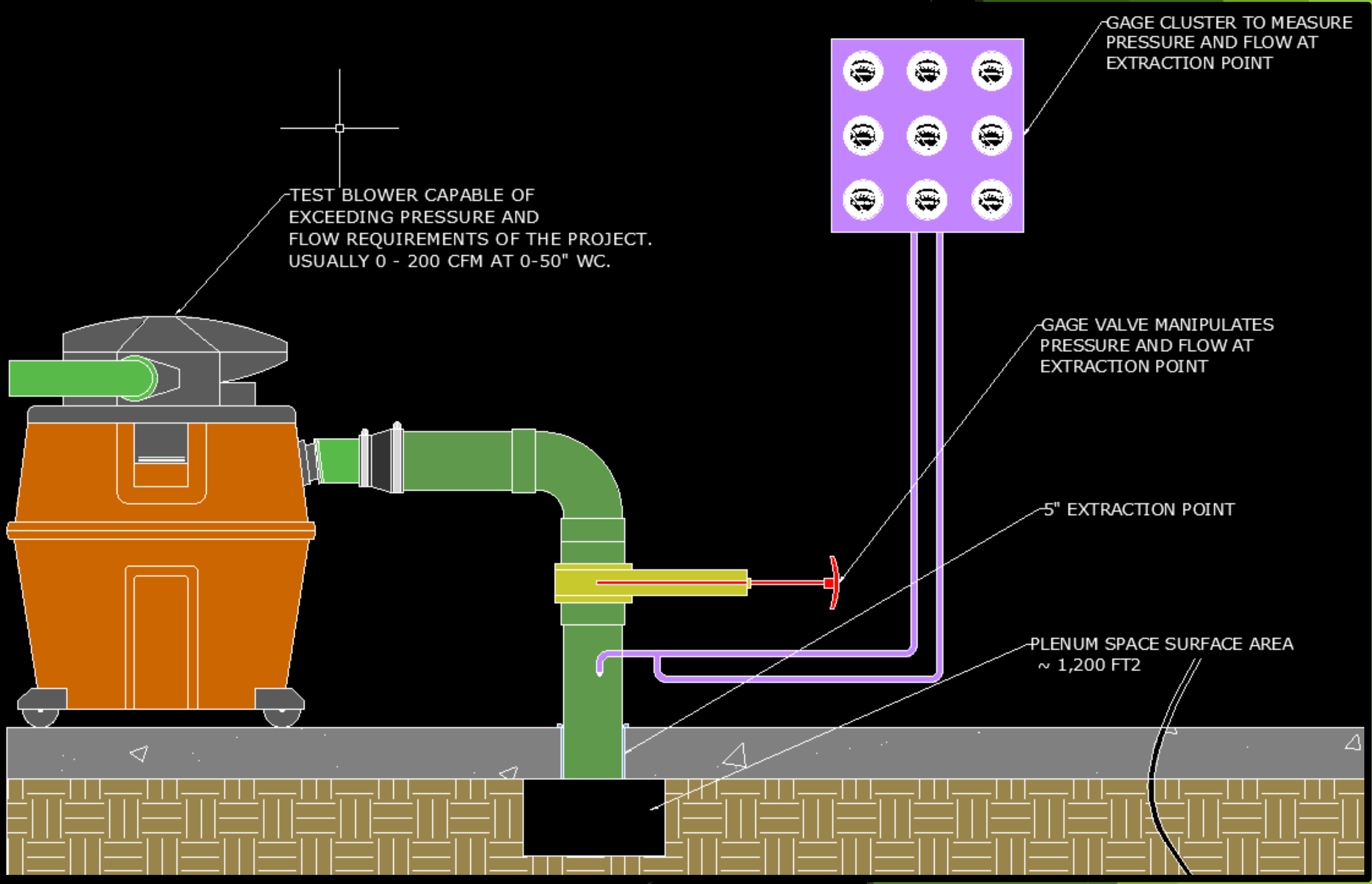
Conduct Pilot Test

- Sound pilot testing methodology is critical to effective system design.
- The goal is to characterize the sub slab flow and pressure requirements to achieve the benchmark pressure across the entire treatment area.

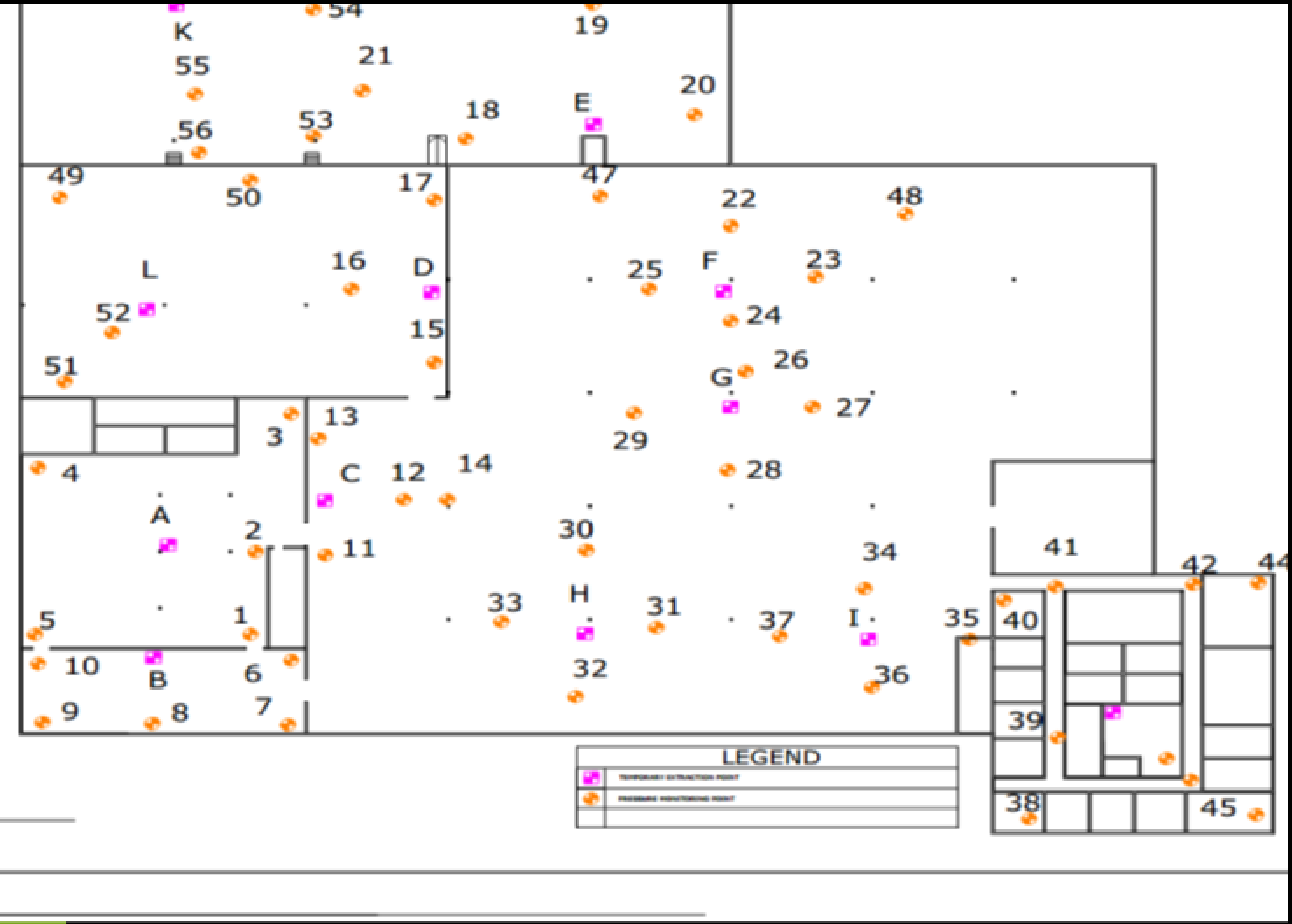
Pilot Test Tools

Proper Pilot Test Methodology

- 5” extraction point (EP)
- Large plenum size
- Valve to regulate pressure and flow at EP
  - Closing the valve decreases pressure and flow at the EP and is accurately recorded on the gages
- Pressure and flow gages below valve
- Correct pipe size



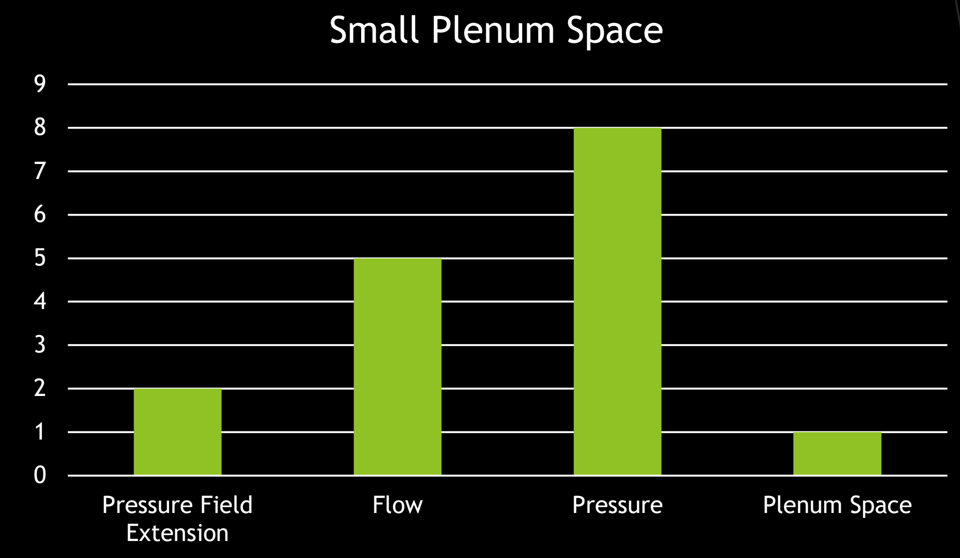
Pilot Test Layout

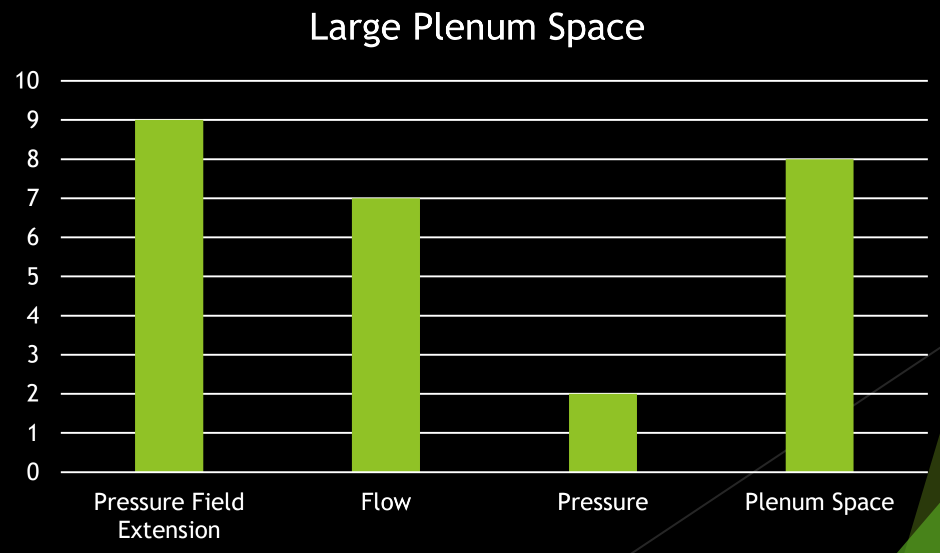


- Install EPs at final install locations if possible
- Install monitoring points at edges of treatment area
- Divide treatment area into smaller sections if necessary

4 Variables of an Extraction Point

- Pressure Field Extension – Size of the area treated with each EP. Varies by EP and building design.
- Plenum Size – Size of the void space beneath the EP.
- Pressure – Amount of pressure at the EP required to maintain the benchmark pressure at the monitoring point.
- Flow – Amount of air moving from the extraction point to maintain the benchmark pressure at the monitoring point.





Assemble an Actionable Dataset

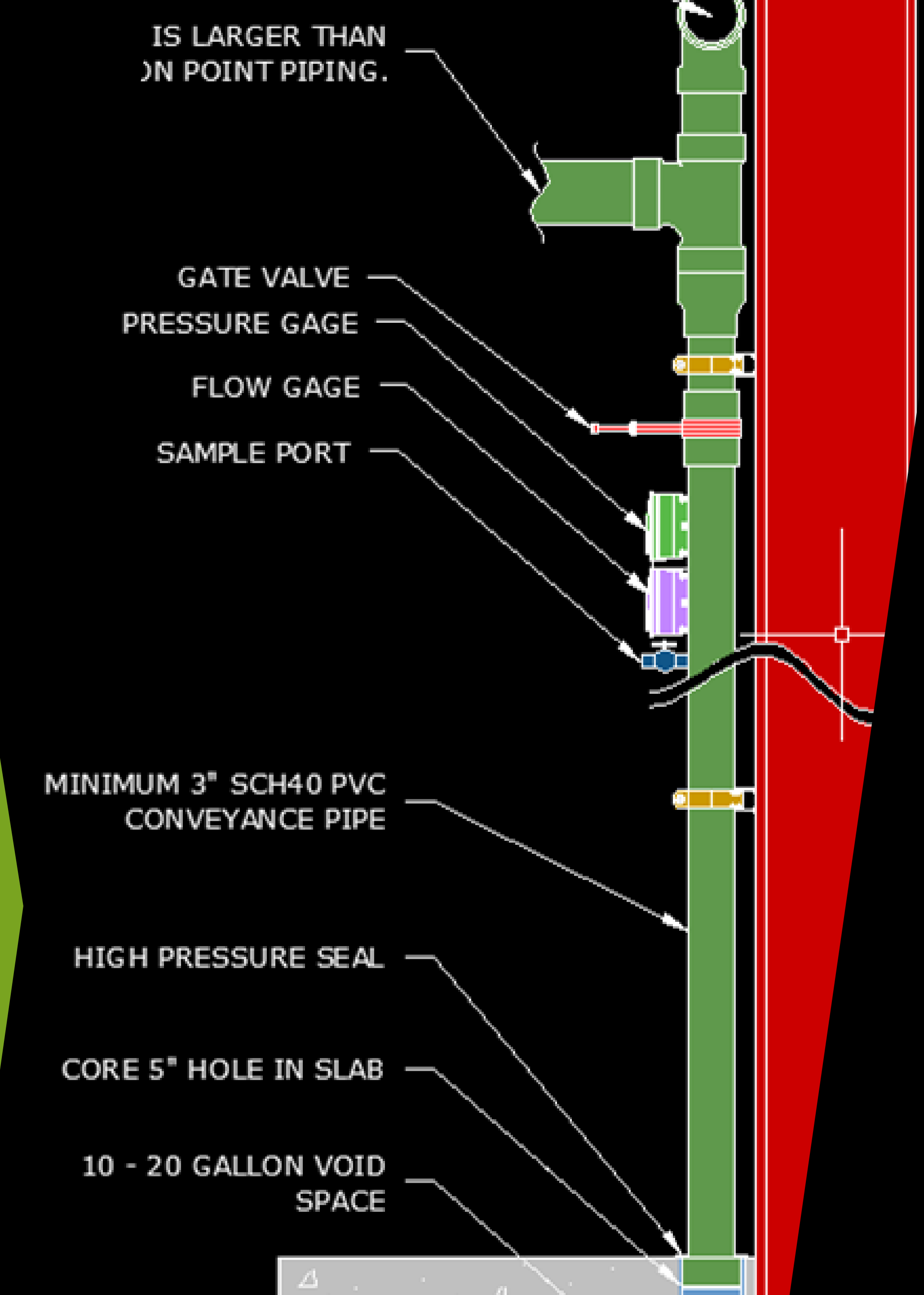
#:	Static Pressure/ Grab Sample	1	2	3	4	5	6	7	8	9	10	11
traction oint #		A	A	B	B	C	C	C	D	D	E	E
oncrete nickness		6.5	6.5	6	6	6	4.5	4.5	7	7	6.5	6.5
ubsidence		0	0	0	0	0	0	0	1	1	1	1
oil		Semi Loose	Semi Loose	Semi Loose	Semi Loose	Semi Loose	Semi Loose	Semi Loose	VB & Rocks	VB & Rocks	VB & Rocks	VB & Rocks
t Size (G)		0	4	0	3	0	4	4	0	4	0	3
ystem ressure		24	20	39	36	44	40	24	3	1.2	32	30
FM		72	90	20	40	24	23	19	78	128	68	65
Test Points (all pressure in Thousandths of an Inch Water Column)					Project Benchmark		-4	Significant Influence			>	-4
1	0	-5	-4									
2	0	-248	-305									
3	0	-1	-1									
4	0	-1	0									
5	0	-1	-4									
6	0			-3	-3							
7	0			-5	-5							
8	0			-5	-7							
9	0			-1	-1							
10	0			0	0							
11	0					-22	-24	-14				
12	0					-20	-23	-14				
13	0					-16	-15	-10				
14	0					0	0	0				
15	0								-3	-2		
16	0								-30	-15		
17	0								-1	-1		
18	0										-119	-114
19	0										-9	-9
20	0										-900	-883
21	0										0	0
22	0											

Calculate Final Quantities

- Extraction Points

- Conveyance Pipe

- Fan Assemblies



Generate Construction Documents

- Layout drawings of system
- Detail drawings of major components
- Installation specifications
- Cut sheets for all equipment
- Project budget
- Many regulators conduct a design review at this phase for compliance to the project standard and to ensure a successful mitigation

Avoid Poor Design

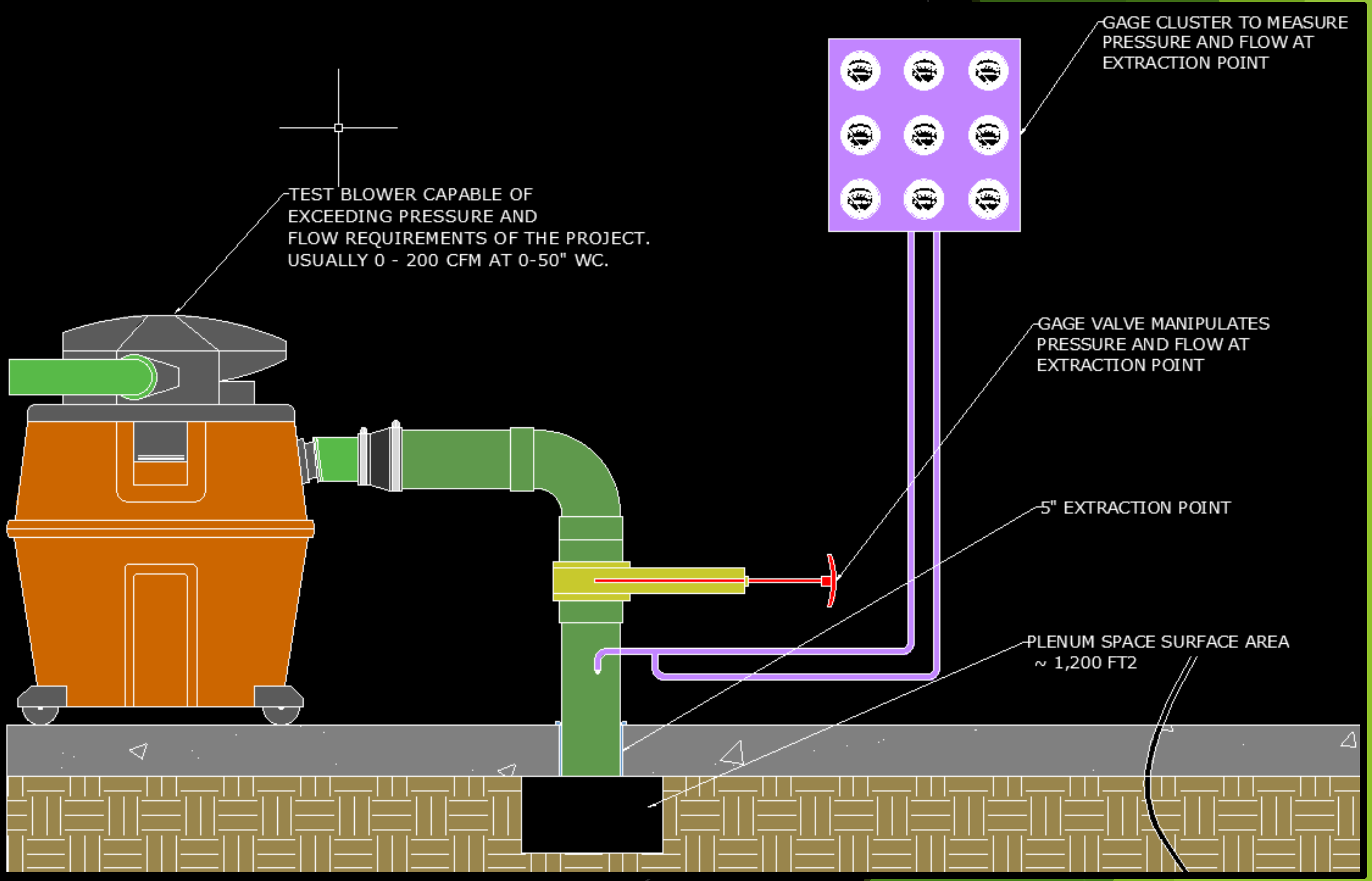
These design errors are an early warning sign for impending project failure. If you notice these errors in your design, consider a design review before installation.

Improper Performance Benchmark

- Benchmark is expressed in Inches of Water Column (WC) or Pascals (P) outside of the US
  - If the design identified any other unit of measure, seek design review by qualified consultant:
    - Inches of Mercury (HG)
    - Pounds per Square Inch (PSI)
- Unusually high pressure benchmark:
  - There should be a clear explanation in the pilot test report for any benchmark above -0.020”
- Design must account for static pressure in a building
    - If the existing pressure is +0.05” and the benchmark pressure is -0.020”, the installed system must create a total pressure change (ΔP) of -0.025”

Proper Pilot Test Methodology

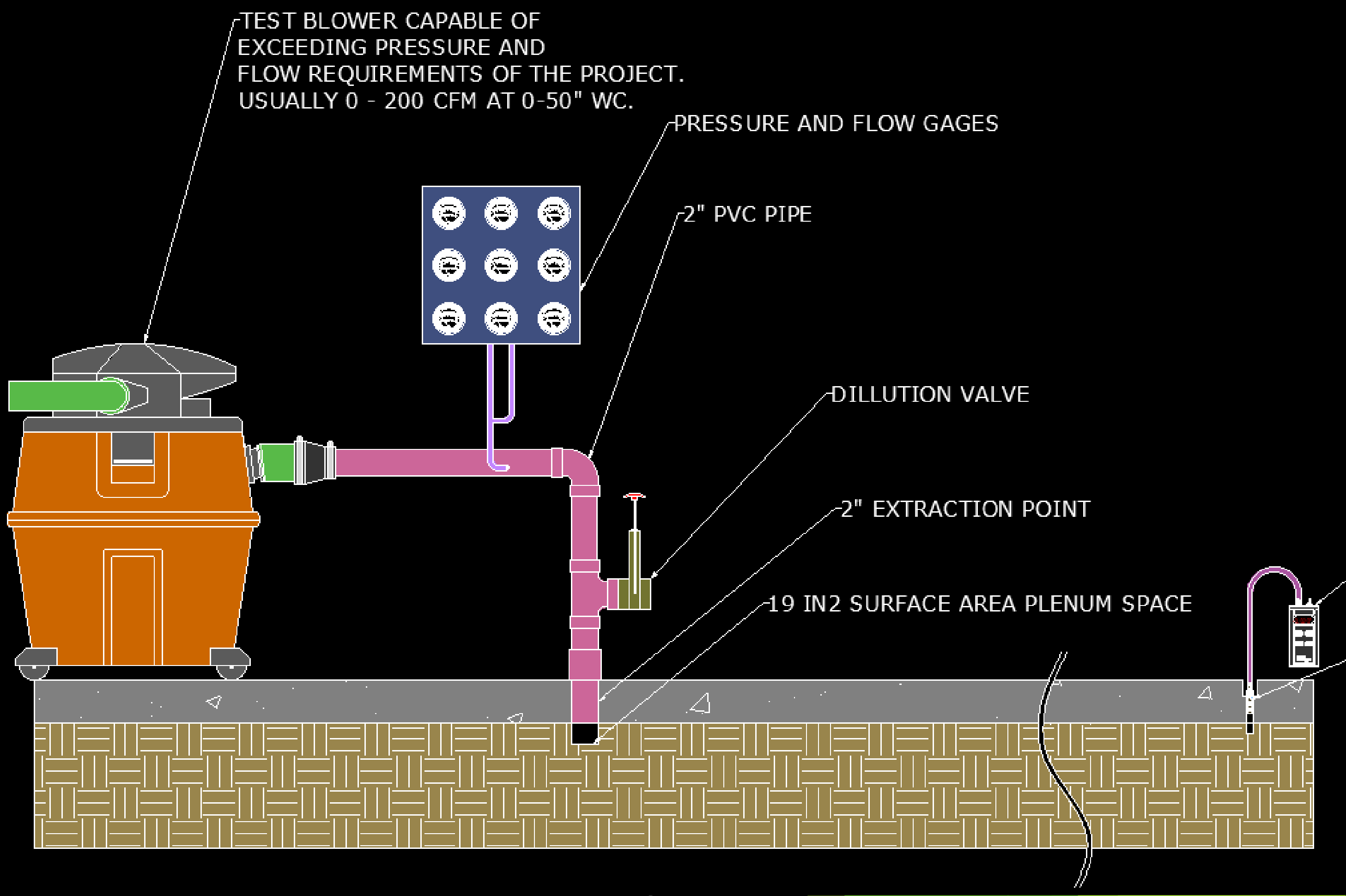
- Pressure and flow gages below valve.
- Correct pipe size
- 5” extraction point (EP)
- Large plenum size
- Valve to regulate pressure and flow at EP
  - Closing the valve decreases pressure and flow at the EP and is accurately recorded on the gages



FLAWED PILOT TEST SETUP

Test Rig Visualization

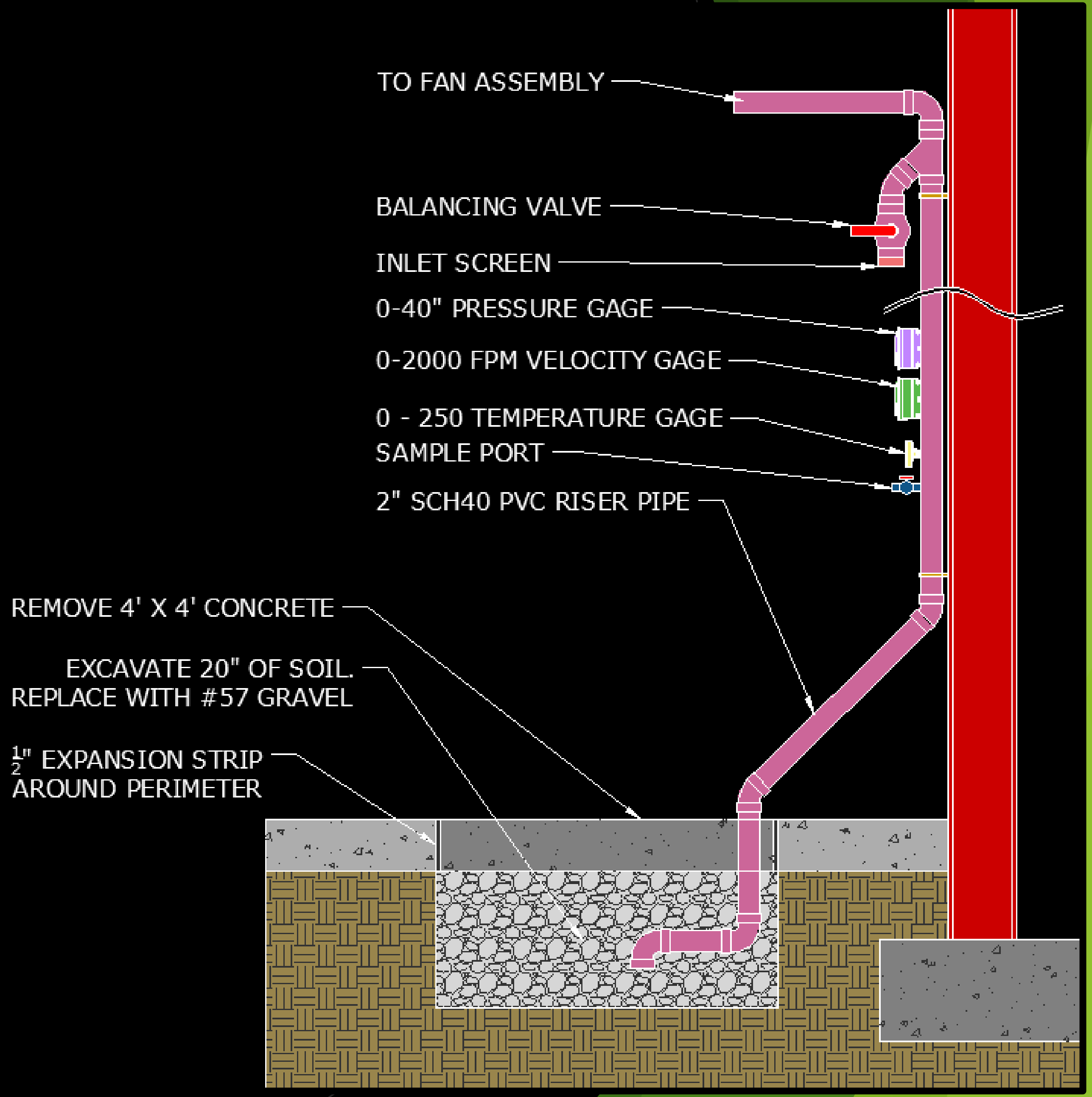
- Valve is incorrect
  - Does not regulate pressure or flow at EP
  - <u>ALWAYS</u> produces best results when closed
- EP should be 5”
  - Necessary for plenum space creation
- Pipe size should be 4”
  - 2” pipe adds unnecessary friction to the system and produces inaccurate results
- Plenum size
  - Too small to gather accurate data
- Gages measure total pressure and flow, not EP
  - Only accurate when valve is closed



Typical Flawed Example

Main Components:

- 2” Conveyance piping
- Dilution valve to regulate pressure
- Gages to measure pressure, flow and temperature
- Sample port
- 16 ft2 of concrete demo
- Remove 20 ft3 of soil
- Install gravel and replace concrete



EXTRACTION POINT

Typical Flawed Example

- Deficiencies:
  - 2” Overhead and EP piping not large enough. 3” is minimum
    - AARST/ANSI RMS LB 7.3.1 – The minimum inside duct diameter from exhaust point to soil gas collection plenum shall be equivalent or greater than the cross sectional area of a 3” inside diameter pipe…
  - Will Cause:
    - Excessive wear on fan assembly
    - Excessive cost to operate oversized fan
    - Insufficient flow
    - Early fan failure
  - Valve location incorrect. Opening valve allows ambient air into the system
    - This method is so far outside the standards that there are no references to it.

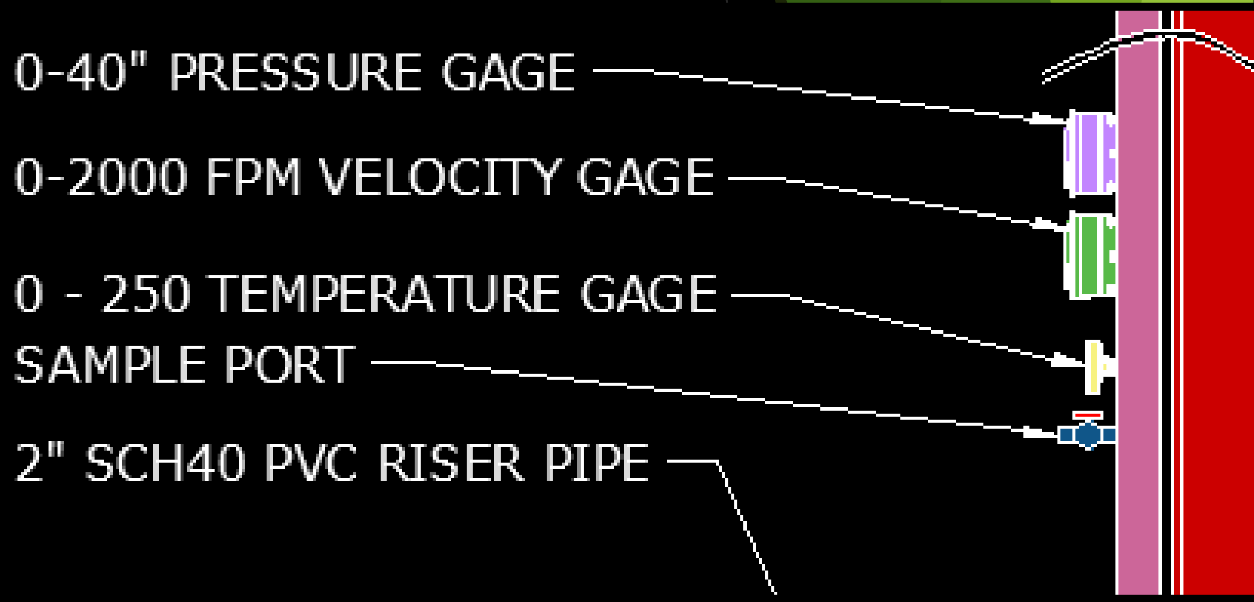
Real World Example

- The diameter of the pipe adds resistance to the system which must be overcome by the blower
- Let's consider a typical system with 300' of pipe
- The Pilot Test indicates total operating pressure of 1.5"WC and 400 CFM

Pipe Diameter	2"	4"
Friction Loss for 300' @ 100 CFM	25.5	1.8
Required Sytem Pressure	1.5	1.5
Total blower pressure requirement @ 400 CFM	27"	3.3"

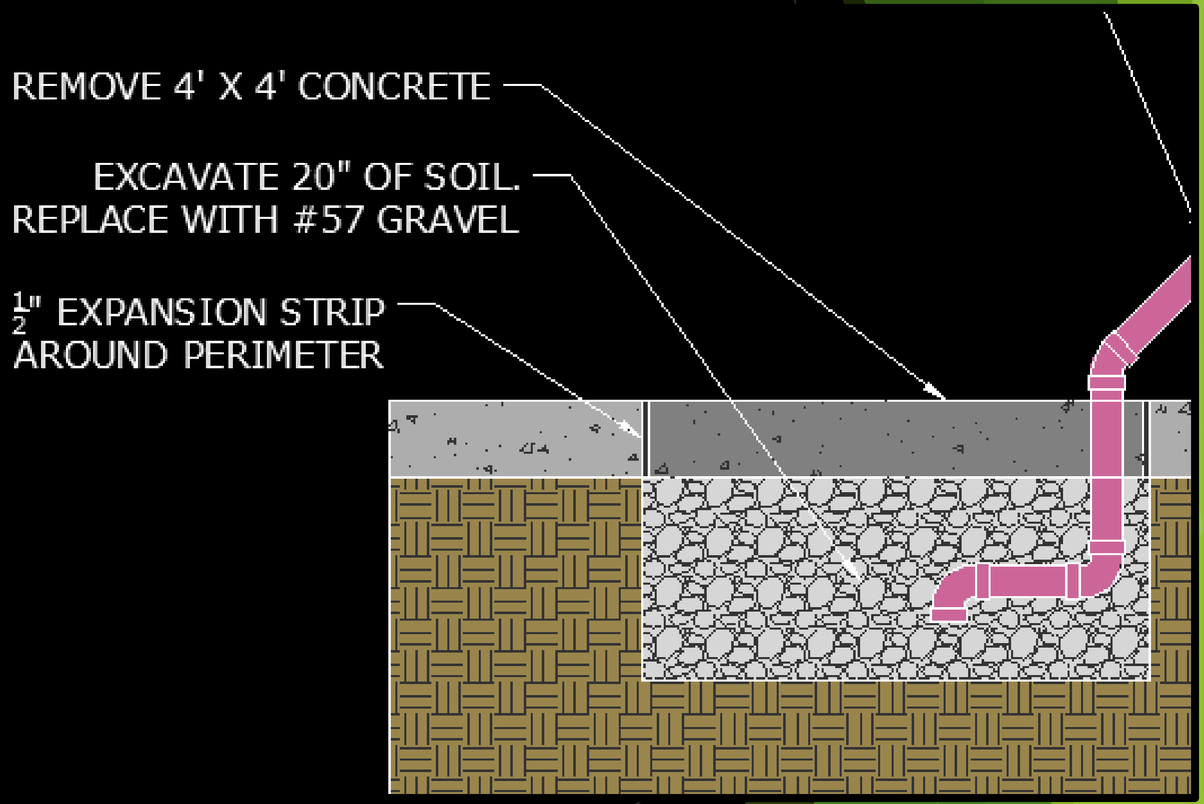
Typical Flawed Example

- Deficiencies:
  - Pressure Gage – OK
  - Flow Gage
    - These are acceptable, but generally not necessary.
  - Temperature Gage - Used to ensure airstream does not rise to autoignition temperature of COC.
    - Naphthalene
      - Autoignition: 525 °C (977 °F; 798 K)
    - PVC Pipe
      - Melting Point: 100 °C (212 °F; 373 K)



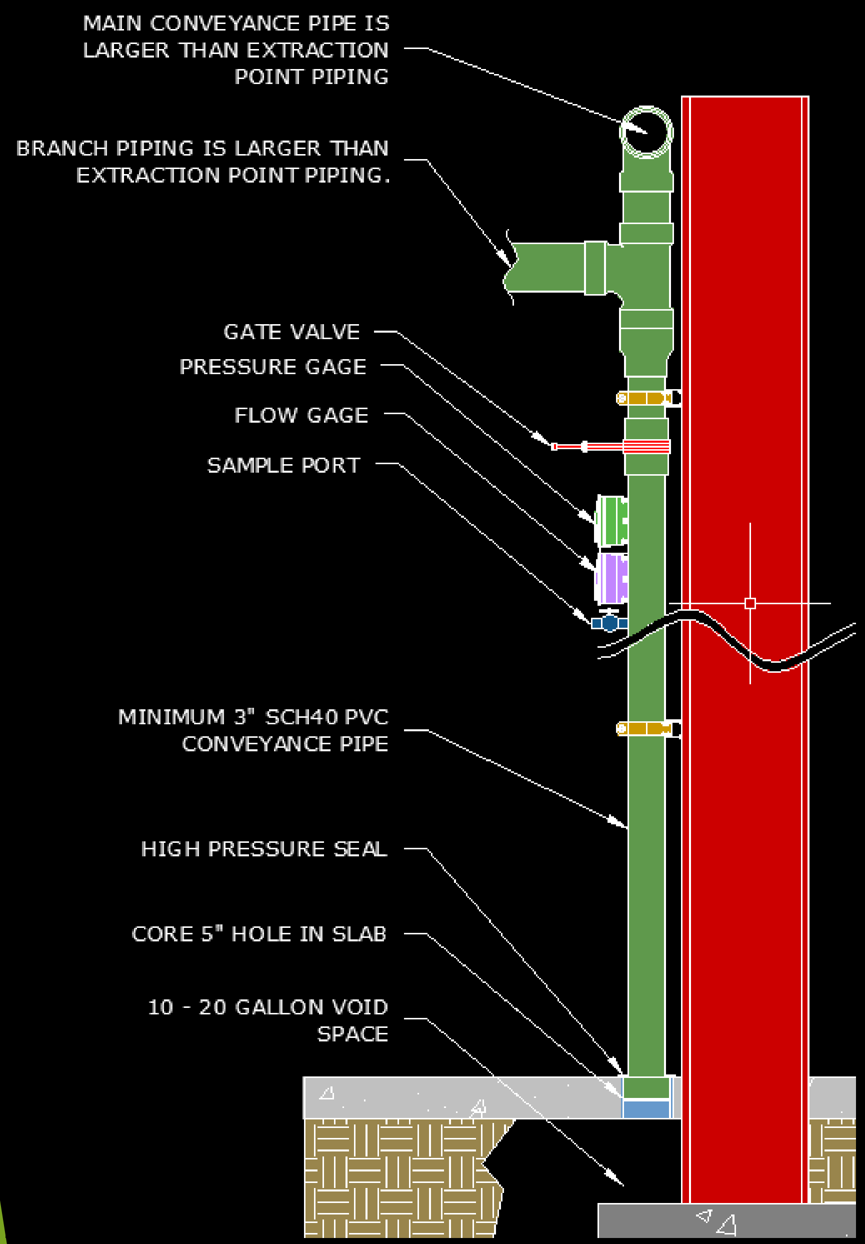
Typical Flawed Example

- Concrete demo at EP. Specified when large extraction pit is required.
- This amount of concrete demo is usually unnecessary and typically specified as part of flawed pilot test methodology.
- Use of expansion strip at concrete joint is problematic. The sealant at the joint is subject to excessive wear and premature failure. Ongoing maintenance is required for the sealant.
- This method also costs about 3x's as much as a traditional EP.



EXTRACTION POINT

Proper Construction Example

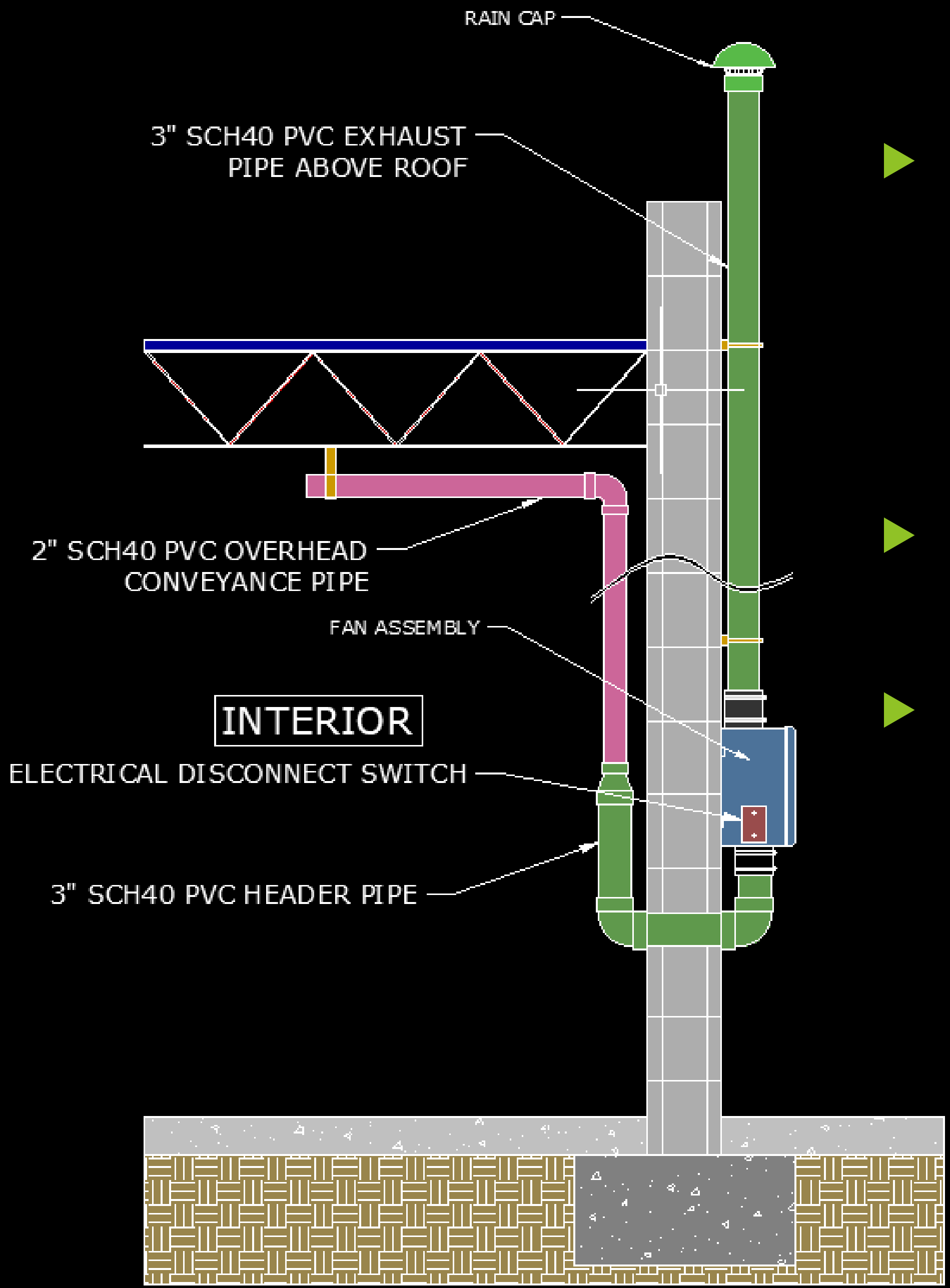


- Small changes make all a big difference.
- Main Components:
  - Overhead piping can accommodate total flow and pressure of entire system.
  - Minimum 3” piping at EP.
  - Ability to regulate pressure and flow via valve.
  - Gage to measure pressure below valve.
  - Optional flow gage below valve.
  - Optional sample port.
  - Robust connection between piping and concrete.
  - Void space large enough to achieve required pressure and flow at EP.

Real Life Example – Extraction Points

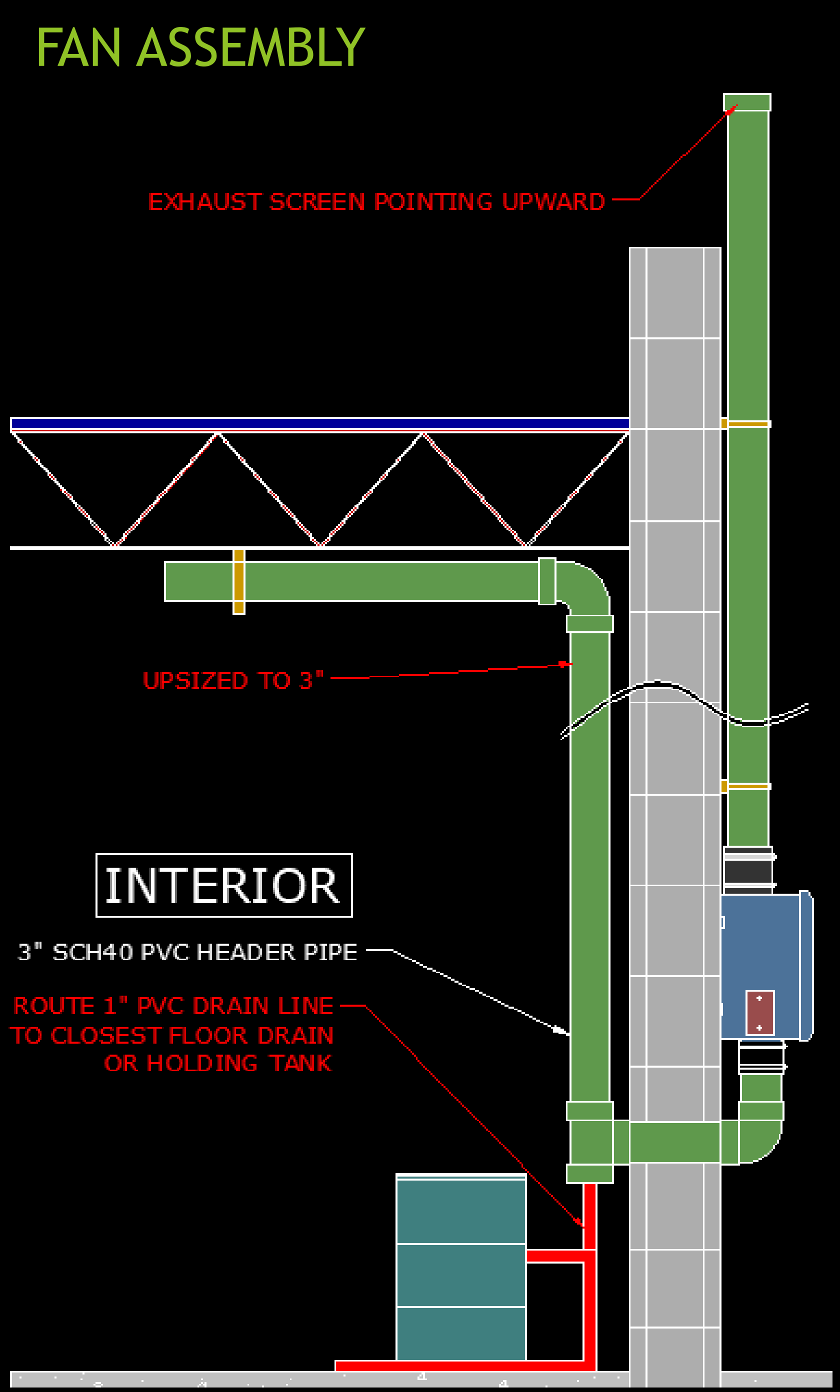
Typical Flawed Example

FAN ASSEMBLY



- Rain caps are incorrect
  - These promote icing over the exhaust when cold outside
  - Direct COC back down toward occupants on ground
- Pipe sizing
  - The 2” pipe is too small
- Pipe routing
  - This arrangement will encourage water to settle below the fan. Water will continue to accumulate until it stops all flow and burns up fan assembly motor

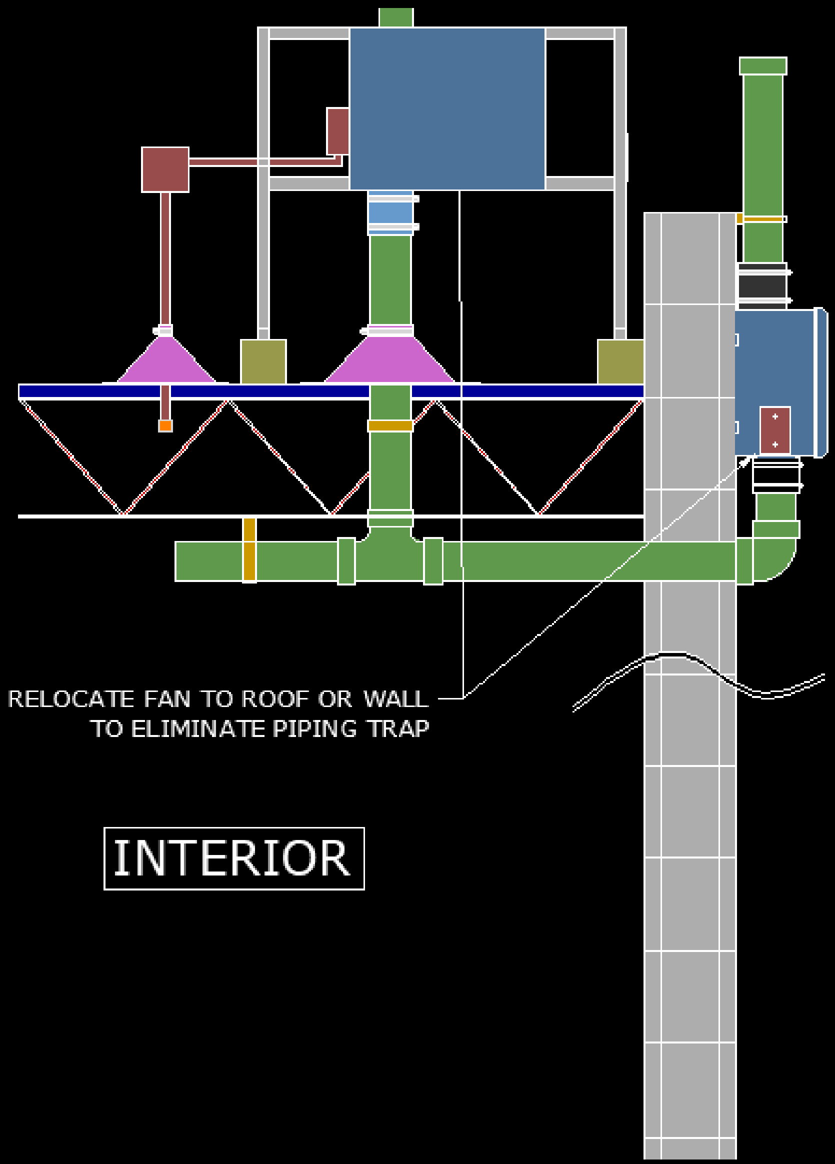
Typical Redesign



- Pipe diameter fixed
- Exhaust screen instead of cap
- Add drain line with trap to floor drain
  - The COC will most likely be present in the water
  - Is it a good idea to drain COCs into the sewer?
- Or add holding tank
  - These should be avoided if possible
  - Continual maintenance issues
  - Continual disposal costs

FAN ASSEMBLY

Correct Example



- Relocate fan higher on exterior wall or move to roof
  - Eliminates all issues
  - Cost of roof flashing installation is significantly lower than monitoring a Knock Out tank for the life of the system

Real Life Example – Built in Drip Leg

Mitigation System Installation

Utilize qualified, experienced professionals to complete the installation

Thank You!

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